

- Fig. 12. Attenuate straight-limbed, knobbed, simple rosette, magnified.
 13. A spinulose hexactinellid spicule with knob, magnified.
 14. An hexactinellid with serrate limbs, magnified.
 15. An hexactinellid with prolonged axis, magnified.
 16. A long, attenuate serrate fibre, magnified.
 17. Plain processes of the skeleton, magnified.
 18. Clubbed cylindrical spined processes, magnified.
 19. The lattice-work at the free edge, magnified.
 20. The lattice-work of the base, magnified.
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On Individual Variation in the Branchial Sac of Simple Ascidians.

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THE difficulty of determining the value of specific characters in Ascidiæ is well known to all who have worked at the group. It is now universally admitted that the old method of describing merely the external appearance of the animal is insufficient; as in many cases it is impossible, from an examination of the external characters alone, to determine the genus, and even in some cases the family, to which the specimen belongs. Consequently, most writers on the Tunicata in recent years have described in more or less detail certain internal characters, including the branchial sac and its related organs, the circlet of tentacles, the dorsal lamina, and the olfactory tubercle. The conditions of these important structures furnish most valuable generic and specific characters, and an account of them should undoubtedly form part of the description of an Ascidian.

It must not be forgotten, however, that some of these characters, in many species, vary considerably according to the individual; or, in other words, not only do varieties exist, but most individuals differ slightly from each other in points which are given as specific characters: this, of course, is only in certain species. Hence when the number of specimens for comparison is small, it is often a delicate matter to determine what is a good species.

My attention was first directed to this variation by reading Lacaze-Duthiers's description, in his great work on the Molgulidæ*, of three marked varieties of branchial sac in *Ctenicella Lanceplainsi*, L.-Duth. This appears, however, from the account given, to be a

* H. de Lacaze-Duthiers, "Histoire des Ascidies simples des côtes de France," 2^e partie, 'Archives de Zoologie expérimentale et générale,' t. vi. p. 619, pl. xxiii. figs. 9, 10, 11 (1877).

case of marked and permanent varieties, and not merely of individual variation. The irregular portion of a branchial sac of *Ascidia scabra*, which I recently figured in the Journal of this Society (*anteà*, p. 284, Pl. XVII. fig. 3), I regard, on the other hand, as merely a local abnormality which I think may be accounted for by the splitting or branching of several neighbouring transverse vessels. I have since met with an exactly similar case of great irregularity in a branchial sac of *Ascidia virginea*, O. F. Müller.

In order to try and determine the extent of individual variation in the branchial sac, and so satisfy myself as to what characters are most constant and may be relied upon in the determination of species, I lately examined minutely the branchial sacs of several of our commonest species of simple Ascidiæ, of which I had a sufficient number of specimens at my disposal. The conclusion I have come to is interesting, but rather unsatisfactory—namely, that certain characters, such as the relative sizes and arrangement of the transverse vessels, the number and position of the internal longitudinal bars, the shape of the meshes, and the number of stigmata they contain, are highly characteristic of some species, and not at all so of others*.

A marked example of the latter class is *Styela grossularia*, v. Beneden, which has such a variable branchial sac that it is almost impossible to obtain specific characters from its details. This species belongs to the Cynthiidae, one of the characters of which is that the branchial sac is longitudinally folded. The normal number of folds in the genus *Styela* is eight, four on each side; but in this species the folds are almost obsolete, being entirely wanting on the left side, and reduced to one on the right. Even that one can hardly be called a fold; it is merely a slight bulging inwards, or projection of the branchial sac, on which there are a number of closely approximated internal longitudinal bars. This single representative of the enormous folds found in most Cynthiidae and Molgulidae is situated in the dorsal part of the right side, and is separated from the dorsal lamina by a broad space free from internal longitudinal bars. A similar space is present on the left side of the dorsal lamina and two others at the ventral edge of the sac, one on each side of the endostyle. These spaces are always larger than the ordinary meshes; but they vary greatly in size in dif-

* I have lately arrived at similar results after an examination of the so-called "olfactory tubercle" as a specific character. (See 'Proc. Roy. Phys. Soc. Edin.' vol. vi.)

ferent individuals. The stigmata are, as a rule, of much the same width; and consequently we may take the number of stigmata in these spaces as a measure of their extent. The commonest number of stigmata observed was sixteen, but numbers down to twelve were frequent, and in one case ten only were present: only once were more than sixteen observed, and in that case there were twenty-three!

The number of internal longitudinal bars on the fold varies from six to nine, and is generally eight or nine. The rest of the right side of the branchial sac, between the fold and the ventral clear space, is divided by the internal longitudinal bars into meshes of varying size, and containing each from two to eight stigmata. The prevailing numbers are six, seven, and eight; but here and there one comes across smaller meshes, generally two or three together, containing each three or four (usually three, rarely two) stigmata.

On the left side of the branchial sac after the dorsal clear space, and therefore in a corresponding position to the fold on the right side, we invariably come upon one or more (generally two or three) of these narrow meshes; and they occur several times between this point and the ventral clear space, just as they do on the right side. There can be little doubt, I think, that these narrow meshes are the almost obliterated or rudimentary representatives of the missing folds. In several new species of *Styela* in the 'Challenger' collection the folds in the branchial sac are in even a more rudimentary condition than the single fold of *Styela grossularia*. They are merely tracts in which the internal longitudinal bars are numerous and closely placed. Now these narrow meshes in the present species are caused merely by three or four internal longitudinal bars being placed more closely together than in the rest of the area. Then the invariable occurrence of three or four of them on the left side next the dorsal clear space seems to indicate that they represent the fold in the corresponding position on the right side. Finally, they form generally three or four longitudinal lines down each side of the branchial sac, and four (one of which is frequently very slight) is the normal number of folds in the genus.

The branchial sac of *Ascidia plebeia*, Alder, has a very characteristic appearance, and is very constant in the size of the meshes, papillæ, &c. There is one point in its structure, however, which seems liable to variation. As a rule, the transverse vessels are all

of the same calibre; but in several specimens which I have examined every fourth vessel is much wider than the intervening three.

In *Ciona intestinalis* the meshes vary somewhat in size in different individuals, but according to no apparent method. Five stigmata in a mesh seems the normal arrangement; four and six are frequently met with, larger numbers more rarely, while ten is the utmost I have observed.

One form of variation remains to be mentioned, viz. the presence of delicate horizontal vessels placed irregularly between the transverse vessels and dividing the meshes into two parts. *Ascidia aspersa*, O. F. Müller, is an example of a species in which these vessels occur as an individual variation. In typical specimens the transverse vessels are all of the same size, and the meshes are square and undivided; but in some individuals many of the meshes (not all) are traversed by these delicate horizontal vessels, and so divided into pairs of transversely elongated areas.

Notwithstanding this liability to individual variation in the branchial sac of at least some species, there is no doubt that the organ is of primary importance in specification. It consequently seems most advisable, in the description of new species, where a sufficient number of specimens is not available to determine which points are constant in the species, to describe the branchial sac and other important organs minutely, so that subsequent investigators may have details of structure in sufficient number to warrant them in assuming that the great majority are constant characters, and that only a few, probably, are liable to variation in any one individual of the species.
